EDITORIAL

Editorial: Exploring and Exploiting Tissue Engineering Through the Design of Multifunctional Therapeutic Systems

Abstract: This article presents a special issue of "Current Stem Cell Research & Therapy" devoted to exploring and exploiting tissue engineering through the design of multifunctional therapeutic systems. This lead article draws from twelve contributed articles to discuss the most recent advancements in this emerging field. The common theme in the contributed articles is the emerging therapeutic strategies, and a special appeal is made for collaboration between engineers and biologists for the development of multifunctional therapeutic systems for tissue engineering and regenerative medicine.

Keywords: Tissue engineering, regenerative medicine, biomaterials, drug delivery, nanotechnology, stem cells, scaffolds, therapeutic molecules.

During the last few years, tissue engineering has widely propagated forward like a tidal wave, providing a new concept for the use of stem cells, small molecules and biomaterials [1]. In contrast to classic tissue repair approaches, the newly proposed strategies aim to induce new functional tissues, rather than simply implanting replacement of alloplastic or allogenic parts [2-4]. This special issue from "Current Stem Cell Research & Therapy" introduced different new strategies using a combination of innovative techniques, biomaterials and stem cells. It also included articles presenting complex biological processes required to restore functionality of tissues when the regulatory function changes. This special issue contains twelve papers that provided deep research results to report the recent advances in the design of multifunctional therapeutic systems for tissue engineering and regenerative medicine.

The first contribution was "Amalgamation of stem cells with nanotechnology: A unique therapeutic approach" by Alexander *et al.* [5]. It is known that due to the ability of cellular differentiation and regeneration of stem cells, they serve as one of the most effective ways for various incurable conditions and severe damages. This short review article presented amalgamation of stem cell therapy with nanotechnology. It then discussed various nanocarrier systems such as carbon nanotubes, quantum dots, nanofibers, nanoparticles, nanodiamonds, nanoparticle scaffold, *etc*. utilized for the delivery of stem cell inside the body.

The second paper of this issue was a critical review by Mohebbi *et al.* [6] entitled "Chitosan in Biomedical Engineering – A Critical Review", trying to revisit the importance of chitosan in the field of biomedical engineering. The authors have successfully presented a comprehensive overview of chitosan with a special focus on emerging applications in medicine, tissue engineering, drug delivery, gene therapy, cancer therapy, ophthalmology, dentistry, bio-imaging, bio-sensing and diagnosis.

The next contribution "Current status of stem cell therapies in tissue repair and regeneration" by Giri *et al*. [7], represented the hidden aspects of stem cells for tissue engineering. This article concisely reviewed the critical role of stem cells and their distinctive capability to differentiate and self-renew for cell-based therapies in nerve, bone, skin, cartilage, bladder, cardiac, liver tissue repair and regeneration.

The benefits of stem cells are not limited to the field of tissue engineering. There are also many other biomedical applications that can benefit from stem cells. Although it is known that stem cells could efficiently serve for tissue engineering and regenerative medicine for particular tissue/organ regeneration in any physical injury or disease, stem cells can also be used in many other biomedical applications for example as a potential diagnostic tool (such as the development of biomarkers) for non-invasive diagnosis of severe disorders. In this regard, the review article "Recent biomedical applications on stem cell therapy: A brief overview" by Agrawal *et al.* [8] summarized the possible usage of stem cell in a broad range of biomedical applications.

As a practical investigation on the role of stem cells in tissue engineering, Ahmadi *et al.* [9] presented an article entitled "Evaluation of hMSCs response to sodium alginate/bioactive glass composite paste: Effect of CaO/P_2O_5, sodium alginate concentration and P/L ratios" to examine the effectiveness of a series of alginate pastes containing bioactive glass nanoparticles for bone repair applications. They found that the pastes made of bioactive glass nanoparticles with CaO/P_2O_5=9.5 and sodium alginate 1% with P/L ratio of 0.8 showed optimum behavior in terms of mineral carrying capacity, injectability, bioactivity, weight loss, wash out behavior, proliferation and differentiation of Human mesenchymal stem cells (hMSCs).

There was also one critical short review article by Babanejad *et al.* [10] entitled "Theranostic platforms against cancerous stem cells", in which a futuristic approach of stem cells in cancer treatment has been presented. As a global challenge, conventional methods exhibit shortcoming in completely treatment of cancer. In this review paper, various therapeutic and diagnostic techniques of cancerous stem cells have been discussed to pave the way for designing proper platforms for cancer eradication.

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The special issue presented two articles on the design of multifunctional therapeutic systems for diabetes. The first one was a concise review article entitled "Stem cell-based therapies: A New ray of hope for diabetic patients" by Khan *et al.* [11]. Recently, cellular approaches through stem cell therapy have emerged as a promising solution for diabetic patients. The review attempted to bring into light clinical studies favoring the transplantation of stem cells in diabetic patients with an objective of improving insulin secretion and improving degeneration of different tissues in response to diabetes. This review article also provided few solutions on the problems associated with successful implementation of this approach and possible directions for future developments. The second article on this subject was "Electrospun nanofibers for diabetes: tissue engineering and cell-based Therapies" authored by Hoveizi *et al.* [12]. The authors have divided this article into two main parts as the principals of cell therapy for diabetes and the usability of tissue engineering scaffolds as a new approach. This article reviewed the studies evaluating the effects of the nanofibrous scaffolds and stem cells for diabetes treatment.

The special issue also hosted three articles on emerging strategies for neurodegenerative diseases though the design of multifunctional therapeutic systems. Babahajian *et al.* [13] compared the effect of administration of Trolox, carnosic acid and Human Chorionic Gonadotropin (HCG) immediately after reperfusion of the stroke tissue on the memory and hippocampal histology. Their findings indicated the beneficial effects of HCG and Trolox on the improvement of memory and the number of healthy cells in the hippocampal region. They also concluded that the apoptosis degree in the hippocampus was significantly reduced by Trolox, HCG and Carnosic acid. In another article on this subject, Mohammadi *et al.* [14] isolated Mesenchymal Stem Cells from chorion and then labeled the cells with DiI and transplanted them into a series of Streptozotocin-induced Alzheimer's disease animal models. They concluded that learning and memory abilities were not significantly improved after stem cell transplantation. Moreover, Chorion-derived Mesenchymal Stem Cells transplantation could successfully engraft in the injured site but the efficacy and function of the transplanted cells were not clinically satisfactory. Future studies should analyze the long-term effect of the cell transplantation and should discover the potential influence of different administration modes of Mesenchymal Stem Cells in various animal models of neurodegenerative diseases. The third article on this subject is presented by Amini *et al.* [15] on the protocol development of adipose tissue-derived stem cells transplantation into the brain through cerebrospinal fluid in rat models. They showed the presence of transplanted human Adipose-Derived Stem Cells (hADSC) in the cerebellum and basal ganglia that confirmed the entrance of transplanted cells into the cerebrospinal fluid and their migration into the brain tissue. The important note was that all the animals survived after the transplantation process, with the lowest side effects compared to the currently available conventional techniques. It was suggested that the developed method of injection was less invasive and was faster than other methods of stem cell transplantation; thus, it could be widely used in experimental studies in mice and rat models.

This special issue ended with an article by Chenani *et al.* [16] on the behavior of a gelatin-silica hybrid material in severe bleeding under different pH values. They examined the effect of particle size on the rapid control of haemostasis. They demonstrated that the developed nano-hybrids could show effective blood absorption up to 470%, while the hybrid haemostatic behavior was limited in alkaline or acidic environment. It was also found that the hybrids with the optimum particle size (Hyb Gel-$NSiO_2$) could maintain the structural integrity with rapid haemostasis in less than three seconds. This study presented an important issue, since the introduced hybrid particles could act as an excellent multifunctional therapeutic system to control excessive bleeding that could be further proposed for clinical evaluations.

In summary, the goal of this special issue was to suggest some new technologies and trends on the design of multifunctional therapeutic systems. The papers provided clear proofs that multifunctional therapeutic systems could play a critical role in emerging biomedical applications such as tissue engineering and regenerative medicine.

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